Claims

We claim:

1. A quantum computing integrated development environment (QC-IDE) comprising:

a computer; and

a computer program executed by the computer, wherein the computer program includes computer instructions for:

designing quantum logic with N qubits; and

compiling the quantum logic into a set of quantum machine language instructions;

wherein the quantum machine language instructions are executable by a quantum computing system.

2. The QC-IDE of claim 1, wherein a set of quantum machine language instructions includes a set of hardware executable instructions, wherein at least one instruction in said instruction set can only be executed on quantum computing hardware.

3. The QC-IDE of claim 2, wherein said set of quantum machine language instructions further includes instructions executable on classical computing hardware.

4. The QC-IDE of claim 1, wherein the computer program includes computer instructions for preparing a sequence of fundamental operators.

5. The QC-IDE of claim 4, wherein the sequence of fundamental operators includes all possible unitary transformations for a particular quantum computing system.

6. The QC-IDE of claim 5, wherein a quantum computing system is any quantum system that provides a universal set of unitary operators.

7. The QC-IDE of claim 5, wherein a fundamental operator has a unitary, 2^N by 2^N matrix.

8. The QC-IDE of claim 7, wherein a single qubit fundamental operator is represented by a unitary matrix $\hat{\sigma}_X = \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$.

9. The QC-IDE of claim 7, wherein a single qubit fundamental operator is represented by a unitary matrix $\hat{\sigma}_Z = \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}$.

10. The QC-IDE of claim 7, wherein a single qubit fundamental operator is represented by a unitary matrix $\hat{\sigma}_y = \begin{bmatrix} 0 & -i \\ i & 0 \end{bmatrix}$.

11. The QC-IDE of claim 4, wherein a sequence of fundamental operators applies to a single qubit.

12. The QC-IDE of claim 4, wherein a sequence of fundamental operators applies to a plurality of qubits.

13. The QC-IDE of claim 1, wherein the computer program includes computer instructions for defining a

sequence of fundamental operators as a single abstract operator.

14. The QC-IDE of claim 1, wherein the computer program includes computer instructions for preparing a sequence of abstract operators.

15. The QC-IDE of claim 1, wherein the computer program includes computer instructions for setting the driver specifications.

16. The QC-IDE of claim 12, wherein the computer program includes computer instructions for setting the frequency of the fundamental operators.

17. The QC-IDE of claim 16, wherein the frequency of fundamental operators can be set for each fundamental operator.

18. The QC-IDE of claim 16, wherein setting the frequency of a fundamental operator includes setting:

the sharpness of the pulses;

the time unit of the pulses; and

the amplitude of the pulses.

19. The QC-IDE of claim 1, wherein the computer program includes computer instructions for selecting a quantum computing system.

20. The QC-IDE of claim 1, wherein designing quantum logic includes defining a quantum computing system.

21. The QC-IDE of claim 20, wherein defining a quantum computing system includes specifying a set of fundamental operations.

22. The QC-IDE of claim 20, wherein defining a quantum computing system includes specifying a noise level in the system.

23. The QC-IDE of claim 20, wherein defining a quantum computing system further includes defining driver specifications.

24. The QC-IDE of claim 1, wherein the computer program includes computer instructions for

preparing a sequence of fundamental operators,

preparing an abstract operator, and

preparing a sequence of abstract operators.

25. The QC-IDE of claim 1, wherein the computer program includes computer instructions for converting said quantum logic between a sequence of abstract operators and a sequence of fundamental operators.

26. The QC-IDE of claim 1, wherein converting between a sequence of abstract operators and a sequence of fundamental operators includes use of a set of simplification rules.

27. The QC-IDE of claim 26, wherein a simplification rule is commutation of fundamental operators.

28. The QC-IDE of claim 26, wherein a simplification rule is redundancy between fundamental operators.

29. The QC-IDE of claim 25, wherein the computer instructions for converting quantum logic between a sequence of abstract operators and a sequence of fundamental operators includes computer instructions for representing each abstract operator in said sequence as an equivalent sequence of fundamental operators.

30. A method for quantum computing, the method comprising:

designing quantum logic with N qubits;

compiling the quantum logic into a set of quantum machine language instructions;

executing the quantum machine language instructions on a quantum computing system; and

outputting results of the execution of the quantum machine language instructions.